Providing a Framework for Seagrass Mapping in Coastal Systems Using High Spatial Resolution Satellite Imagery

Megan Coffer, Ph.D.
NOAA GST
megan.coffer@noaa.gov

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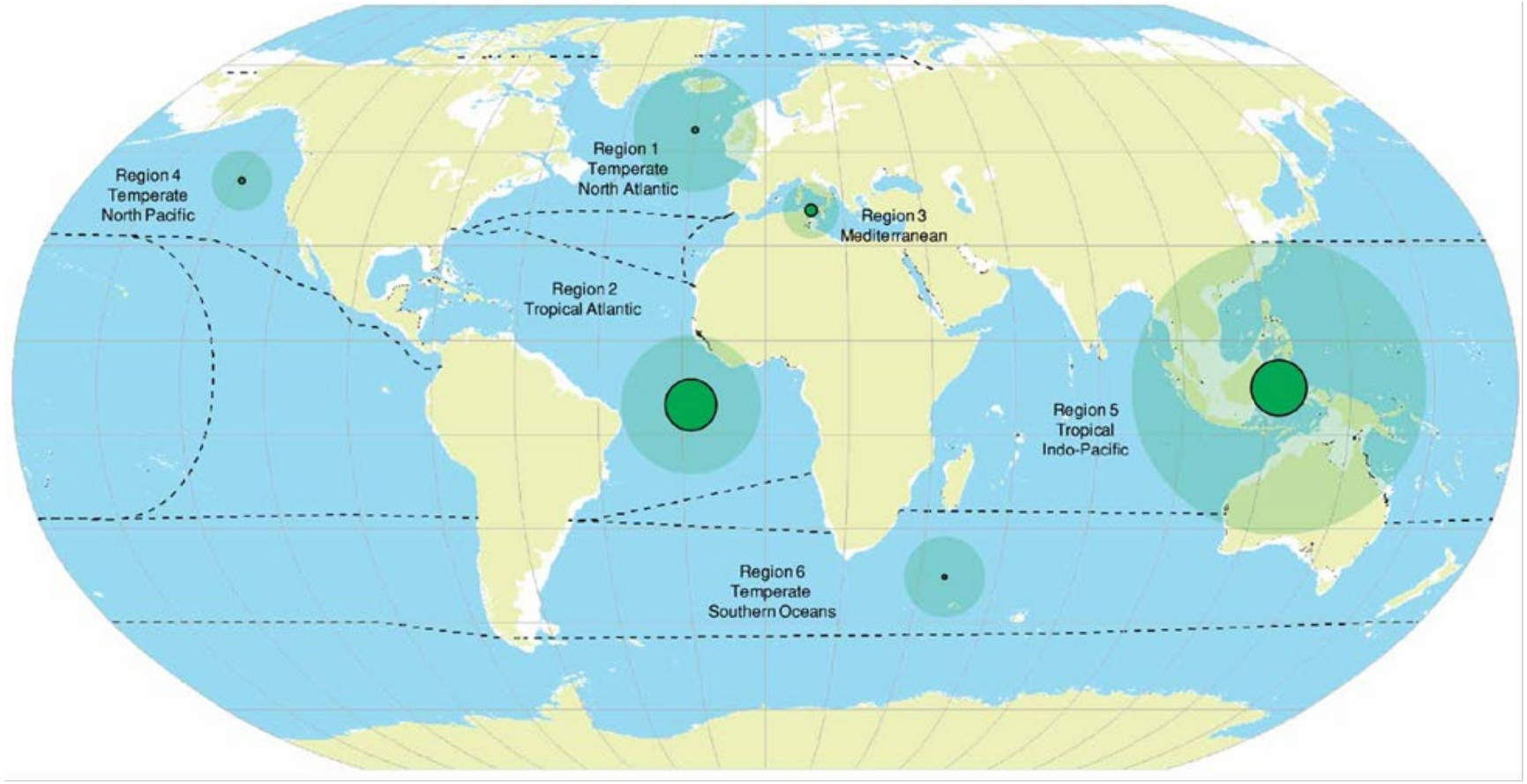
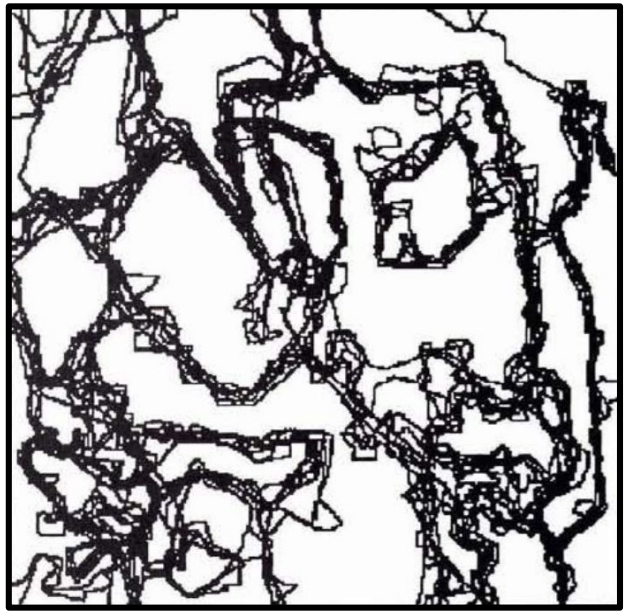
Ramesh et al., 2019. *Coastal Manag.*



Estimated global seagrass coverage ranges between 150,000 and 4,320,000 km²

McKenzie et al., 2020. *Environ. Res. Lett.*

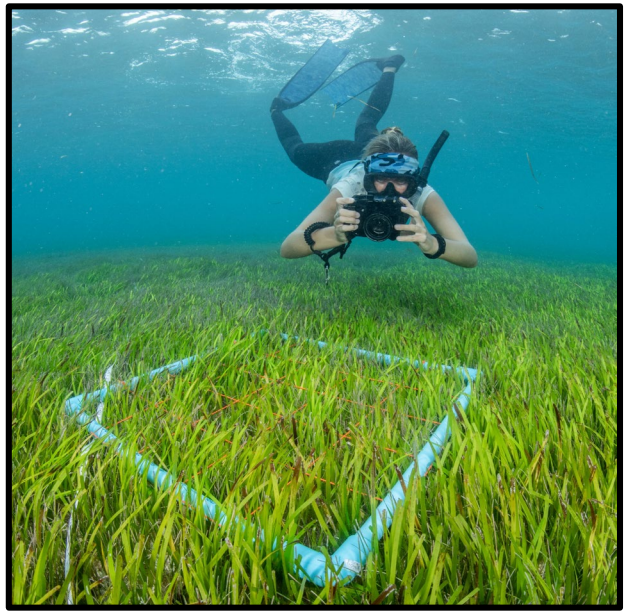


Aerial photointerpretation

Inconsistent results

Cost prohibitive

Time consuming



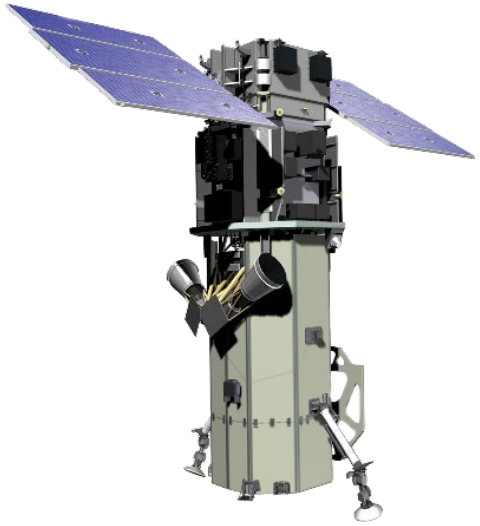
Field quadrats

Low spatial coverage

Time consuming

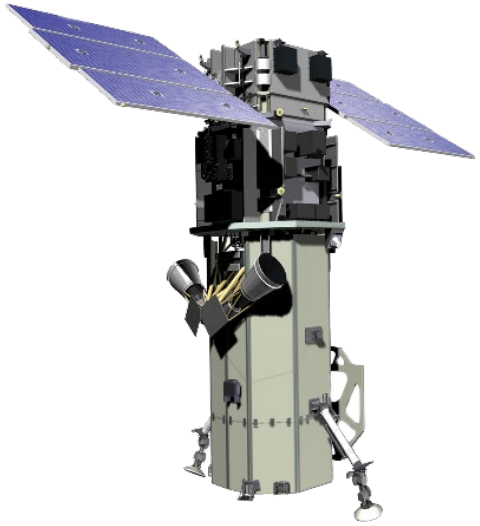
Many areas inaccessible

Edwards & Lowell, 1996 *Photogramm. Engin. Rem. Sens.*



Maxar's WorldView-2
Lifespan: 2009 to present
Spatial resolution: 1.84 m
Spectral resolution: 6 visible, 2 NIR
Temporal resolution: inconsistent & unpredictable

Maxar's WorldView-3
Lifespan: 2014 to present
Spatial resolution: 1.24 m
Spectral resolution: 6 visible, 2 NIR
Temporal resolution: inconsistent & unpredictable



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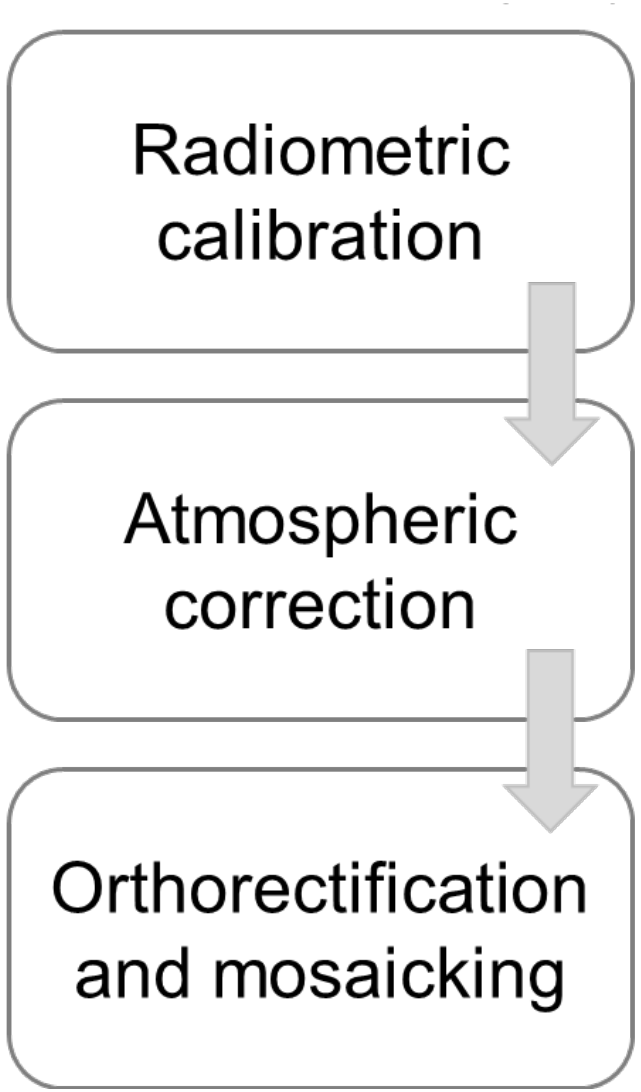
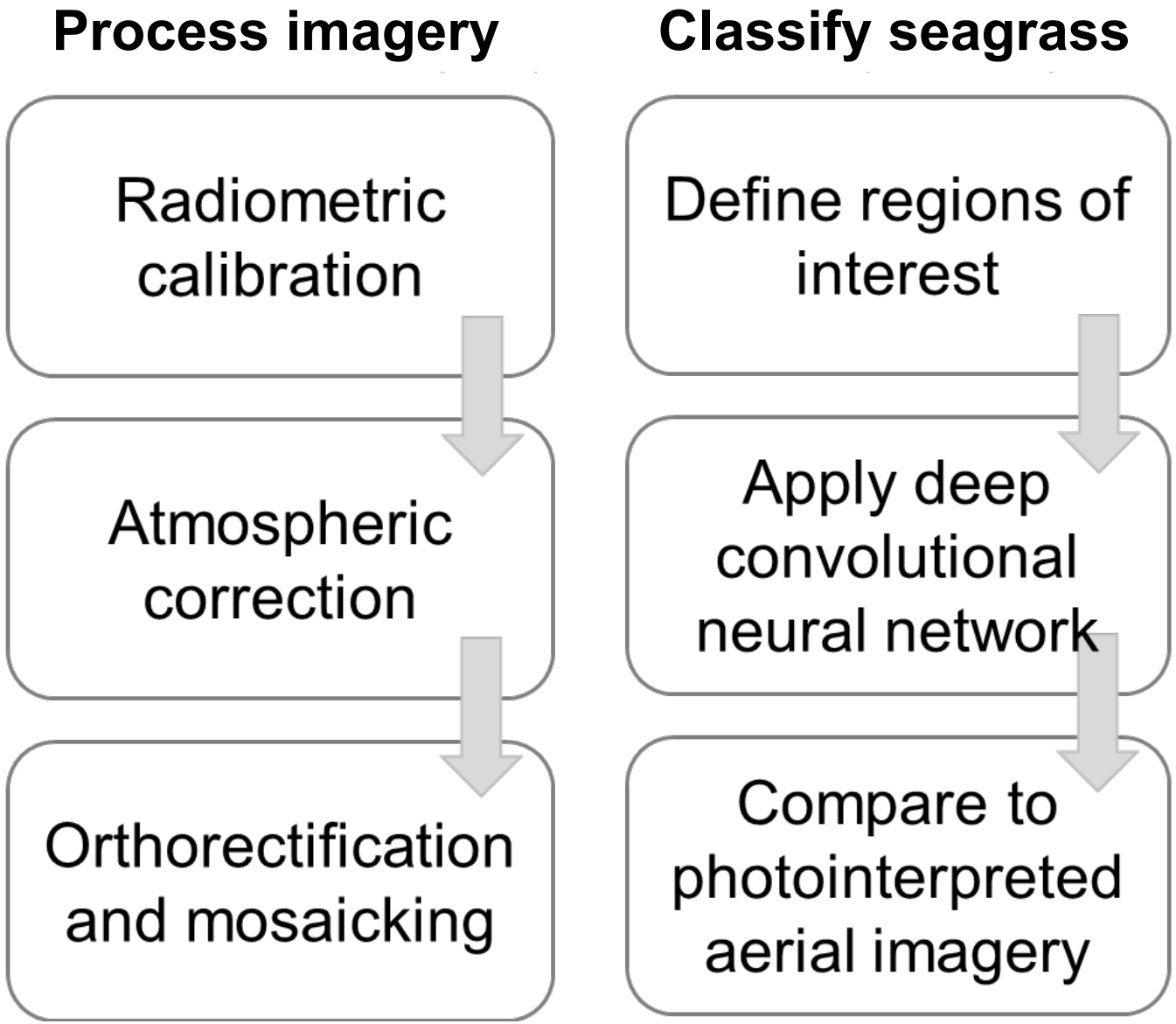
Most studies focus on a single study area, limiting reproducibility

Process imagery



Coffer et al., 2020. *Rem. Sens. Environ.*

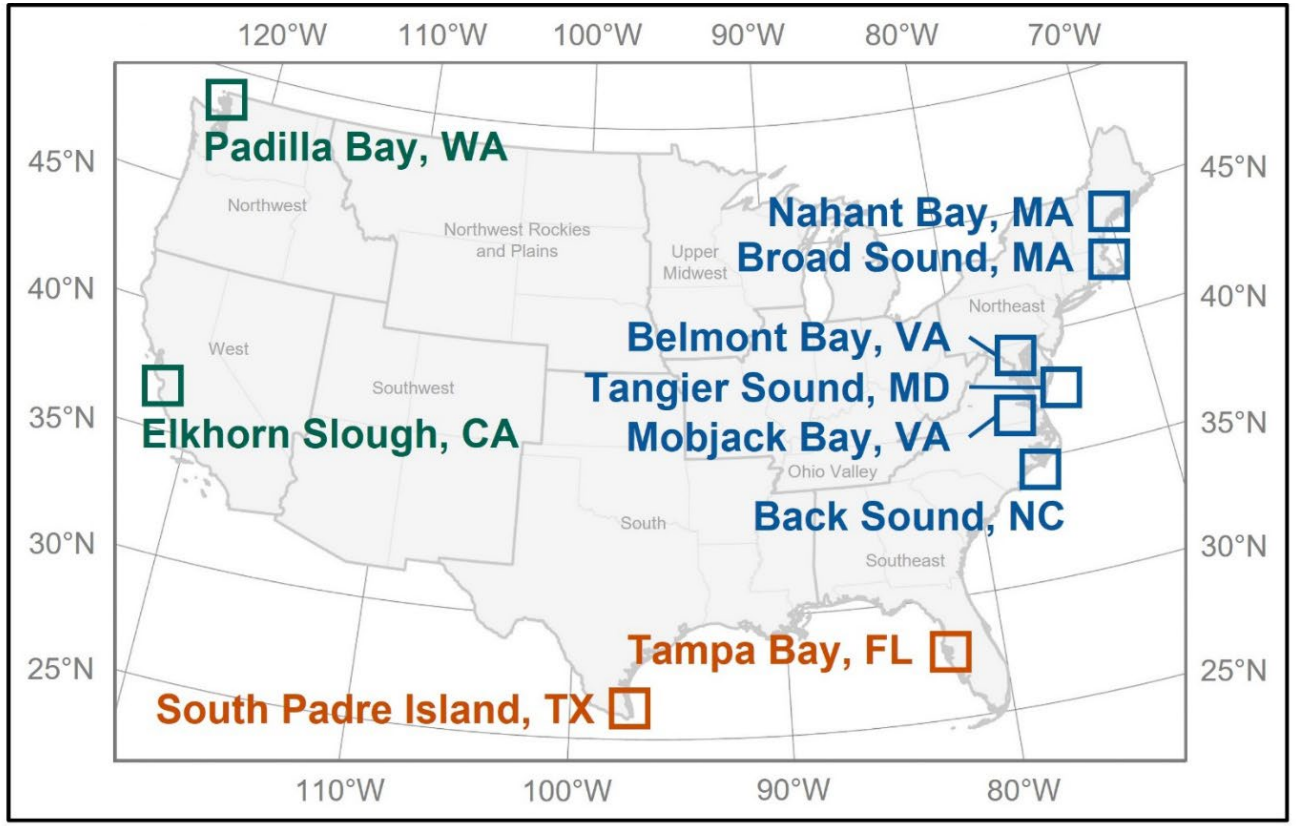


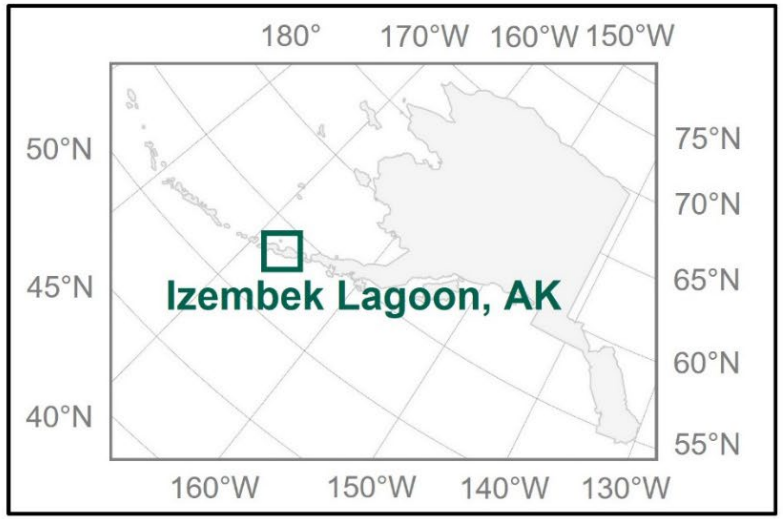
First reproducible processing regime for WorldView-2 & WorldView-3

Tested at St. Joseph Bay, FL, with 97% overall agreement

Coffer et al., 2020. *Rem. Sens. Environ.*

How well does our image processing and seagrass classification regime first defined in Coffer et al. (2020) perform in more complex optical environments?





Seagrass bioregions:

Temperate North Pacific

Tropical Atlantic

Temperate North Atlantic

11 study sites, representing 3 of 6 global seagrass bioregions and each coastal United States climate region

Coffer et al., In review. *J. Environ. Manag.*

For each study area

Reference data

Obtain seagrass reference data from local mapping efforts

Satellite imagery

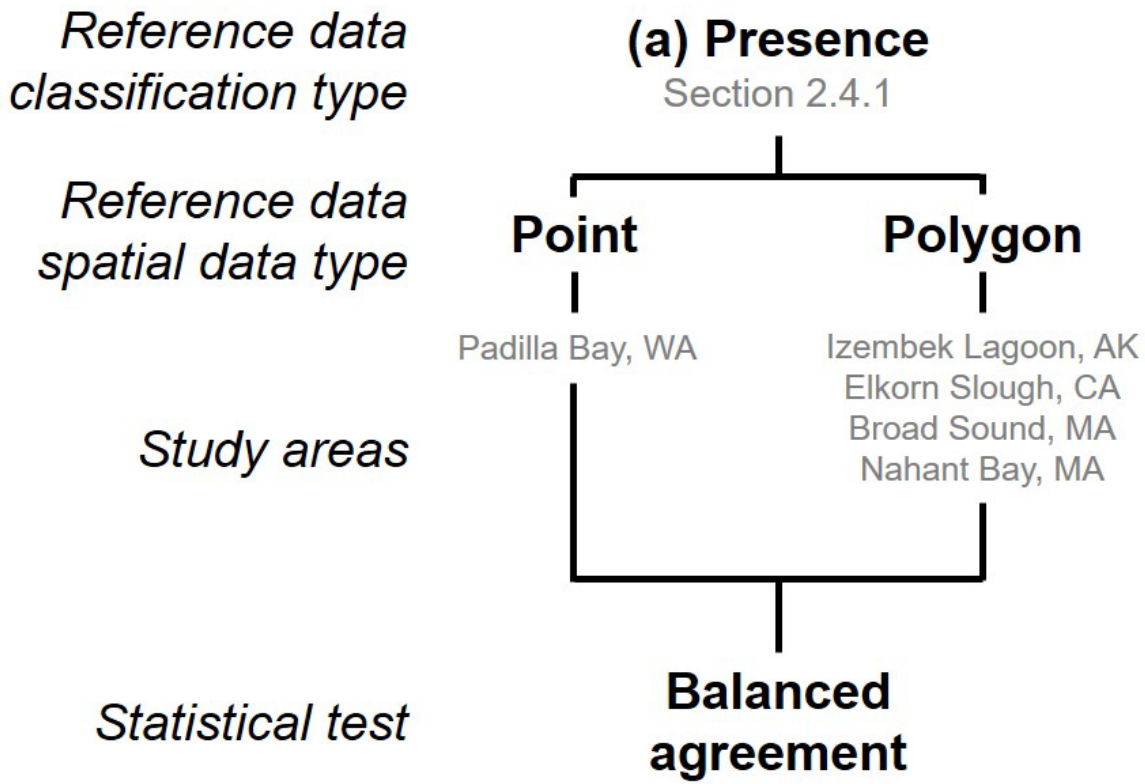
Acquire spatially coincident Worldview-2 or WorldView-3 imagery, targeting minimal temporal offset and visually ideal water clarity

Satellite processing

Following Coffer et al. (2020), apply preprocessing and image classification

Assess agreement

Depending on reference data format, between reference data and satellite image classifications



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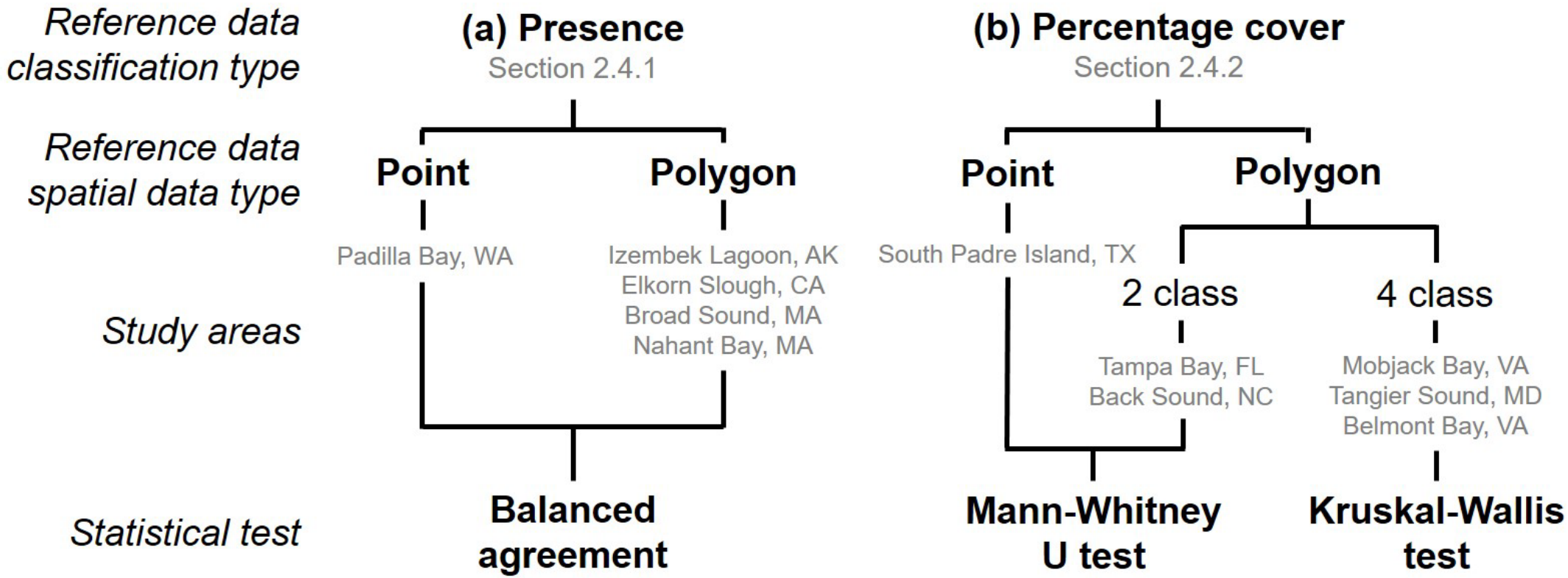
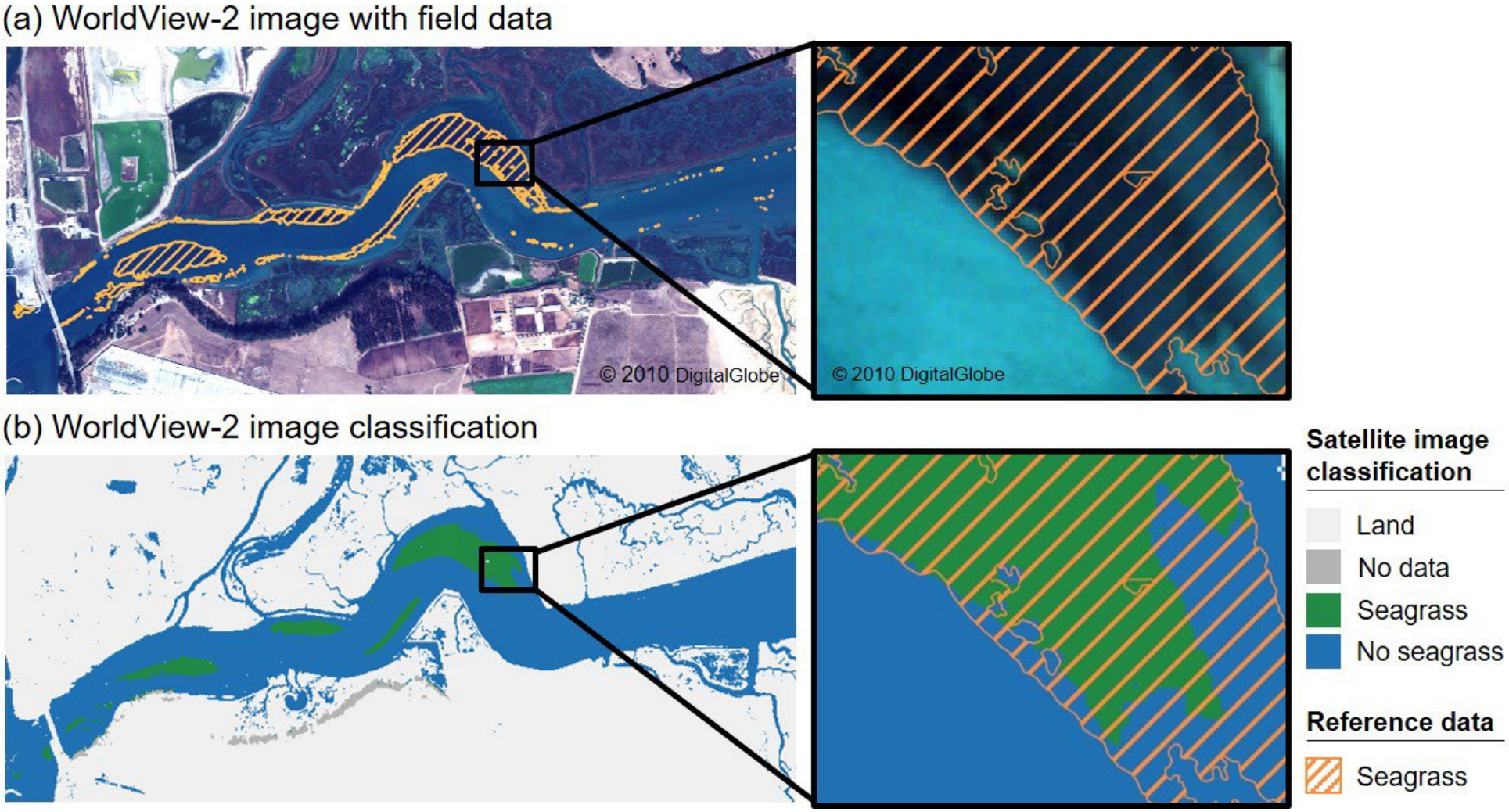


Novel statistical approaches for comparing pixel-based satellite data to polygon-based reference data

Coffer et al., In review. *J. Environ. Manag.*

Elkhorn Slough, CA



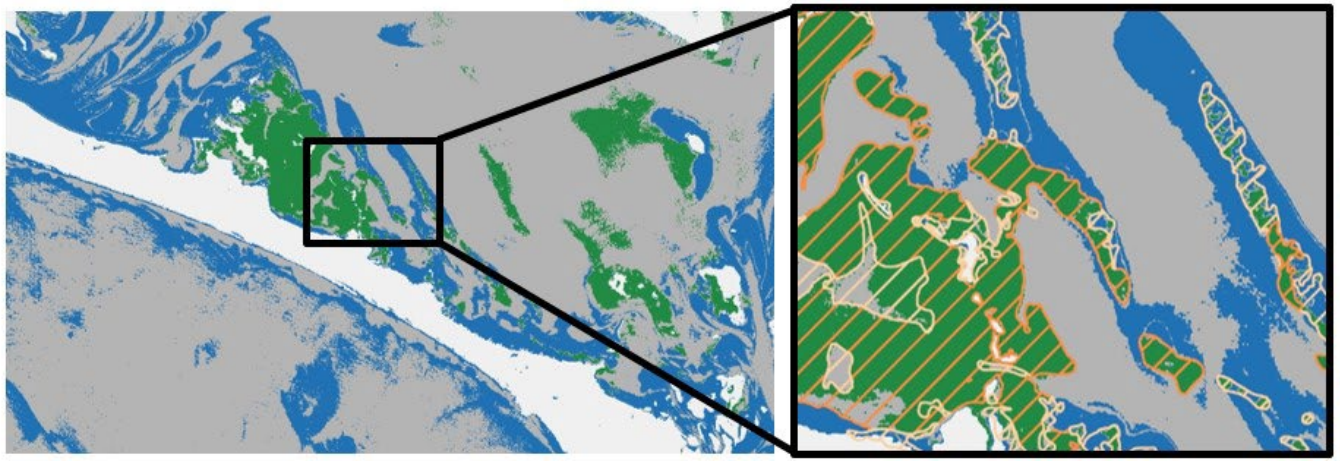
86% balanced agreement (73% sensitivity; 100% specificity)

Coffer et al., In review. *J. Environ. Manag.*

Back Sound, NC

(a) WorldView-2 image with field data

(b) WorldView-2 image classification



Satellite image classification

- Land
- No data
- Seagrass
- No seagrass

Reference data

- Patchy
- Continuous

Coffer et al., In review. *J. Environ. Manag.*

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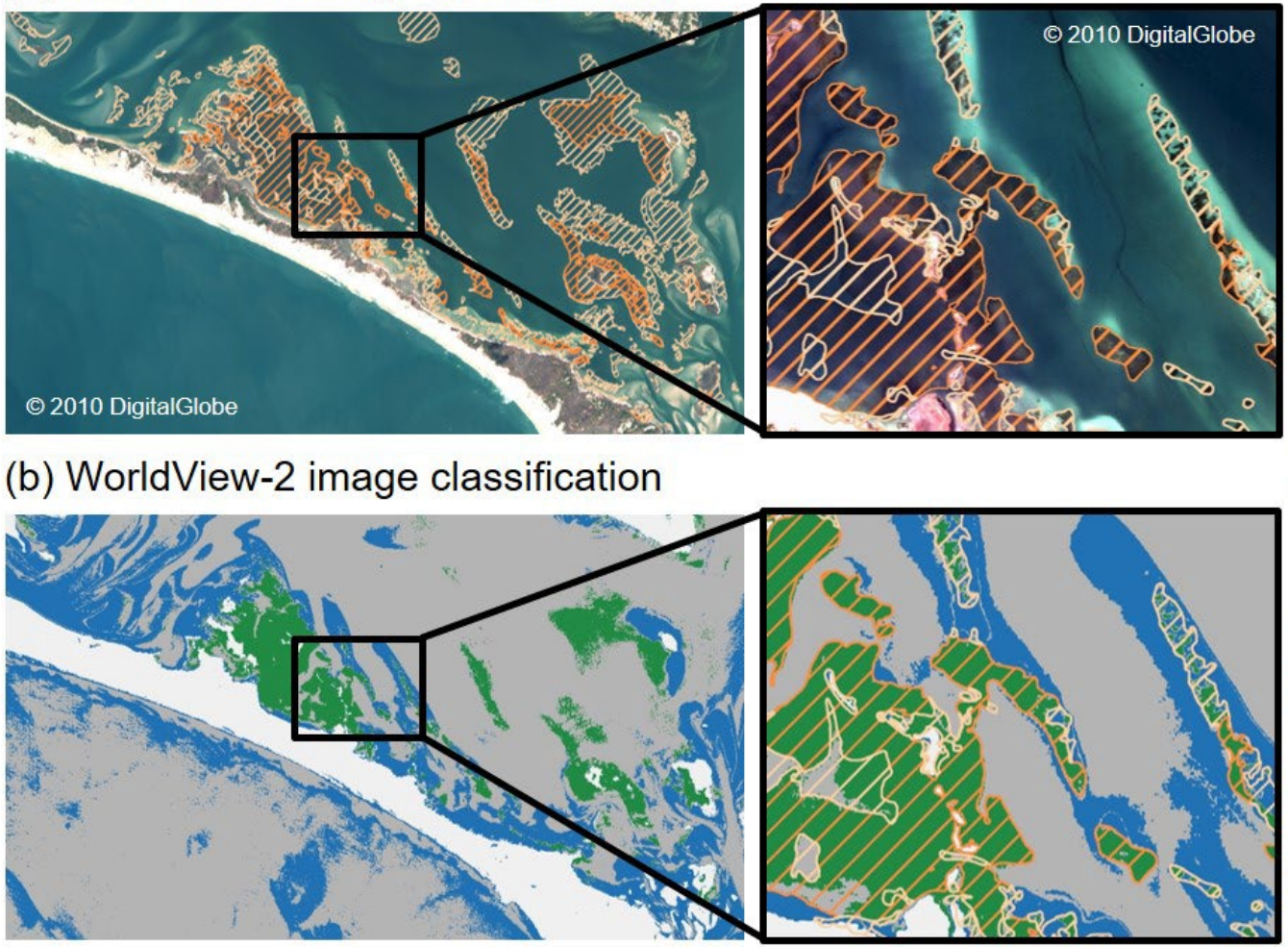

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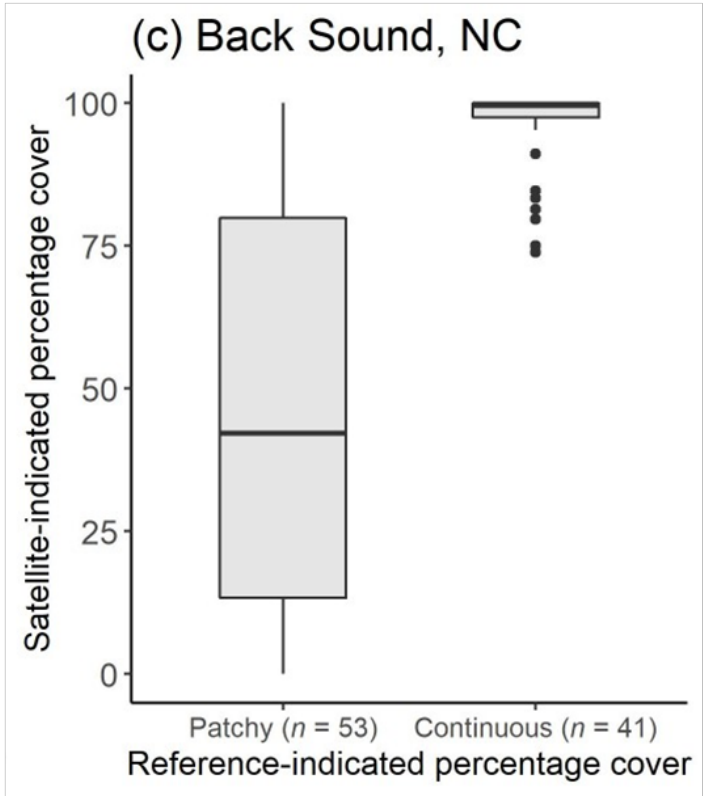
M = 42% M = 100%

r_{rb} = 0.83; large association between datasets



Large associations indicate agreement between datasets

Coffer et al., In review. *J. Environ. Manag.*

Satellite data misclassifications

Sparse seagrass: Likely underestimated as bright sand dominates

Spectral similarity: Algae and seagrass are often intermixed, and all substrates had similar spectral features at depth

Low SNR: WorldView-3 may be less appropriate for aquatic applications (Coffer et al., 2022 *Int. J. Remote Sens.*)

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Dataset mismatches

Temporal offset: Ranged from 1 month to 16 years

Spatial offset: Raster data being compared to point and polygon data

Agreement between satellite and reference data

Balanced agreement ranged from 58% to 86%, with better agreement for seagrass absence

Mann-Whitney U and Kruskal-Wallis tests demonstrated moderate to large correlations between datasets

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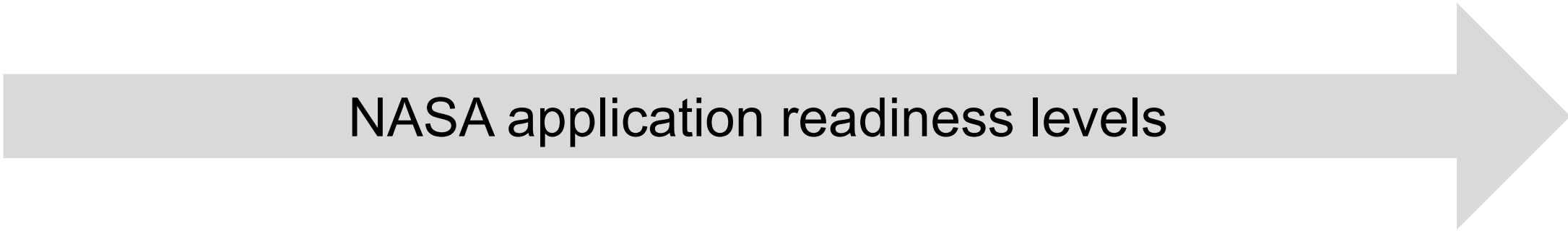
Regional and global mapping

The same methods can be applied across varying seagrass bioregions, atmospheric conditions, and optical water types

Marks a significant step toward developing a consistent, operational approach for mapping seagrass coverage at large scales

APPLICATIONS

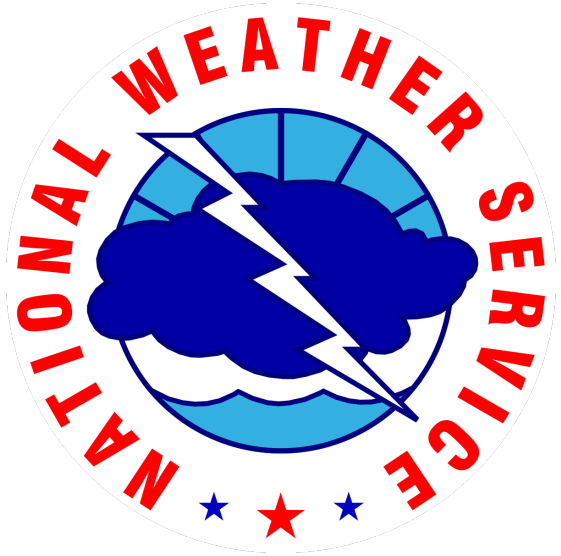


Phase 1:
Discovery and feasibility

Phase 2:
Development, testing, and validation

Phase 3:
Integration into partner's system

1. **Numerical weather prediction models:** *Initialized using satellite imagery and local observations*
2. **Local forecasts generated:** *Model output analyzed and scrutinized using localized, individualized scientific expertise.*



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Methods presented here should be used in the same manner. Satellite data and local knowledge are used to estimate regional seagrass coverage which is then tailored by local experts.